Combined Ranking Method for Screening Collision Monitoring Locations along Alberta Highways

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ABSTRACT

This paper examines the results of combining two common screening methods: Critical Collision Rate and Weighted Severity, to develop an effective and practical method for identifying intersection sites for further on-site evaluation. The critical collision rate screening method has been used widely among practitioners to adjust for high collision rates resulting from low traffic volumes; however, the critical collision rate method does not account for collision severity. Conversely, the collision severity method equates the severity of collision to a common base, but does not account for traffic exposure and the rate in which collisions are occurring.

Alberta Transportation developed a collision screening method that combines a weighted severity with the critical rate of collisions. This combined method is simple, efficient and more accurate than basic screening methods and accounts for collision severity as well as the traffic exposure. The analysis shows combining these two common screening methods provides the greatest number of special monitoring locations (locations with three or more similar collisions in five years), multiple severe collision types, highest traffic exposure and greatest number of collisions occurring at at-grade intersections when compared to other screening methods.

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1.0 INTRODUCTION

Alberta Transportation undertakes screening analysis to identify highway intersections that are potential candidates for in-service safety reviews. The analysis is in support of the Alberta Traffic Safety Plan with a primary goal of reducing fatal and serious injury crashes on provincial highways.

A new screening method has been developed to rank intersections that exhibit the worst safety performance (black spot list) for the highway network. This new safety screening method uses collision frequency, collision rate (exposure) and collision severity to derive a priority intersection ranking list for the province for the purpose of applying in-service safety reviews and programmed work to improve safety performance.

Recently approved national guidelines published by TAC (1) for network screening of collision-prone locations provides details for recommended and interim screening methods. It also provides guidance for the agencies to select the methods that are compatible with their current resource availability and screening needs.

The Alberta Transportation's screening method is a combination of the two recommended interim methods identified in the guideline, that is, the equivalent property damage only (EPDO) method and the critical collision rate method, also named the rate quality control method. The combined method addresses some of the issues/weaknesses associated with each of the two methods – it accounts for exposure as well as collision severity. The results of the intersection safety screening show this method provides the greatest number of special monitoring locations, multiple severe collision types, highest total traffic entering and the greatest number of collisions when compared to other screening methods.

1.1 Collision Data

Alberta's provincial highway network consists of over 20,000 at-grade intersections, and 5995 of these at-grade intersections had one or more collisions during the five year period from 2003-2007. Only intersections having at least one collision in the five year record is included in the analysis outlined within this paper. Collisions involving animals were removed from the data set. Collision data for highways through large cities in Alberta were not included. In order to evaluate the effect of different screening calculations, intersections were not categorized into different types such as signalized / unsignalized, 4-legged / 3-legged, etc.

2.0 CRITICAL RATE METHOD

The Critical Collision Rate method, also know as the Rate Quality Control Method, has been widely used among transportation agencies to determine whether the collision rate at one location is significantly higher than other locations having similar characteristics. The Critical Rate Method for safety screening uses a statistical test to determine whether the collision rate for an intersection is abnormally high when compared to other intersections.

A Critical Collision Rate is calculated using the rates for all intersections having similar characteristics. If the rate for an intersection exceeds the critical rate, the intersection is deemed to be considerably greater than average. The critical rate also adjusts for intersections having low traffic volumes, which tend to produce high collision rates with only one or two collisions present.

The actual Collision Rate which is compared to the Critical Collision Rate for an intersection is computed using equation 1:

$$R = \frac{C \times 10^8}{\sum AADT \times 365.25} \qquad \text{(Equation 1)}$$

Where:
C = number of collisions in the five year collision record,
$\sum$AADT = the sum of the average daily traffic entering the intersection for each year over the five years

Example: average annual daily traffic entering the intersection is 21400, 22000, 22300, 22600 and 23060, respectively for years 2003-2007.

During this five year period, there were 117 collisions at the intersection. Find the collision rate.

R = [117x 10^8] / [(21400 + 22000 + 22300 + 22600 + 23060) x 365.25]
R = 287.7 collisions per 100 million entering vehicles

The Critical Collision Rate is calculated using equation 2:

$$Rc = Ra + k\sqrt{\frac{Ra}{m}} + \frac{1}{2m} \qquad \text{(Equation 2)}$$

Where:
Rc = Critical Collision Rate
Ra = Average collision rate for all intersections
m = Millions of vehicles entering intersection
k = constant (k=1.282 using 90% confidence level)

Example: The average daily traffic entering an intersection is 21400, 22000, 22300, 22600 and 23060, respectively for years 2003-2007. Find the critical collision rate using 90% confidence level (k = 1.282).

M = (21400 + 22000 + 22300 + 22600 + 23060) x 365.25 = 40.67 million vehicles

Ra = assume 57.6 collisions per 100 million entering vehicles (or 0.576 collisions per million entering vehicles)

$Rc = 0.576 + (1.282)(0.576/40.67)^{1/2} + 1/(2x40.67)$
$Rc = 0.576 + 0.153 + 0.012$
Rc = 0.741 collisions per million entering vehicles
or 74.1 collisions per 100 million entering vehicles.

The analysis is completed for all intersections and presented in the graph shown in Figure 1.

Figure 1: Graph Showing Intersections with Collision Rates Above and Below the Critical Rate Line

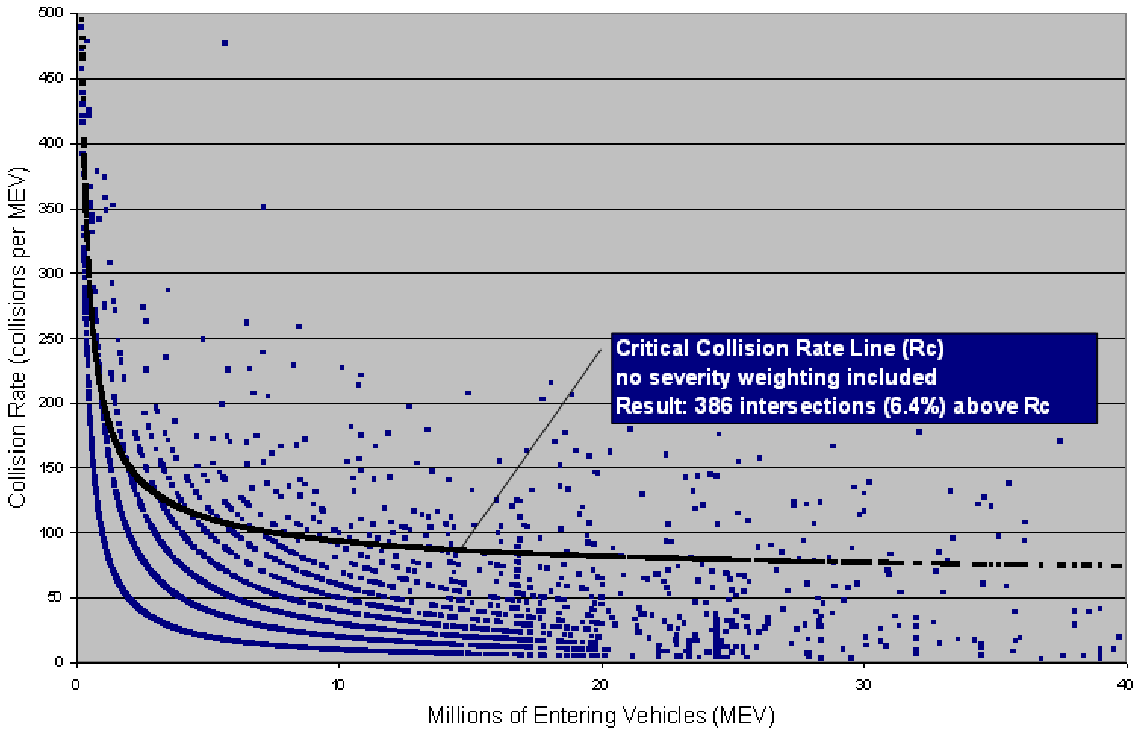


Figure 1 shows there are 386 intersections that are above the critical rate line and would be identified as requiring a safety review to determine how to improve the safety at the intersection.

One weakness of the above method is that the critical collision rate calculation does not take collision severity into consideration.

3.0 WEIGHTED SEVERITY METHOD

Another widely used method for safety screening is to equate the collision frequency in terms of Equivalent Property Damage Only (EPDO) collisions. A weighting factor is applied to injury and fatal collision types to derive a common base. The calculation is outlined in equation 3.

$$EPDO = 100F + 100MAJ + 10MIN + PDO \quad \text{(Equation 3)}$$

Where:

EPDO = Equivalent Property Damage Only collision frequency
F = Number of fatal collisions
MAJ = Number of major injury collisions
MIN = Number of minor injury collisions
PDO = Number of Property Damage Only collisions

Example: in the 2003-2007 collision record, an intersection recorded 1 fatal collision, 2 major injury collisions, 8 minor injury collisions and 13 Property Damage Only collisions. Find the weighted collision frequency.

EPDO = 100 (1) + 100 (2) + 10 (8) + 13
EPDO = 393 equivalent property damage only collisions

This calculation is repeated for all intersections in the population, and ranked according to the highest EPDO. Safety studies would be carried out on the highest ranked intersections as resources and budget will allow.

The literature shows various weighting values have been used to calculate the Equivalent Property Damage Only frequency as shown in the table below. These are further evaluated in the next section.

Fatal	Major Injury	Minor Injury	PDO	Source
100	100	10	1	TAC (1)
40	40	3	1	FHWA* (2)
9.5	9.5	3.5	1	ITE (3)

* Weighting is calculated using Alberta's Fatal / Injury / PDO cost proportions according to the procedure outlined in the FHWA publication.

In selecting the appropriate weighting, care should be taken so that fatal and/or injury crashes are not weighted too heavily, which can lead to biases in the ranking of high-hazard locations by over-emphasizing intersections having only a few severe crashes. The EPDO severity method also doesn't account for exposure, where more collisions are expected to occur with increasing traffic volume.

4.0 CRITICAL COLLISION RATE USING WEIGHTED SEVERITY

This paper's objective is to outline a screening method which could account for both the rate and severity of collision data.

4.1 Weighted Critical Rate (using 100/100/10/1 severity weighting)

One methodology (2) suggests inserting the weighted severity (EPDO) which was calculated in equation 3 and substitute it with the collision frequency used in equation 1, as outlined in equation 4:

$$Rw = \frac{EPDO \times 10^8}{\sum AADT \times 365.25} \qquad \text{(Equation 4)}$$

Where:
Rw = the collision rate using the weighted severity (EPDO)
EPDO = the equivalent property damage only collisions in equation 3
$\sum$AADT = the sum of the average daily traffic entering the intersection for each year over the five years

Example: average annual daily traffic entering the intersection is 21400, 22000, 22300, 22600 and 23060, respectively for years 2003-2007.

During this five year period, there were 393 equivalent property damage only collisions at the intersection. Find the collision rate.

Rw = [393x 10^8] / [(21400 + 22000 + 22300 + 22600 + 23060) x 365.25]
Rw = 966.2 collisions per 100 million entering vehicles

The Critical Collision Rate (Rcw) using the weighted severity in the collision rate calculation is found using equation 5:

$$Rcw = Raw + k\sqrt{\frac{Raw}{m}} + \frac{1}{2m} \qquad \text{(Equation 5)}$$

Where:
Rcw = Critical Collision Rate using EDPO collision rate
Raw = Average EPDO collision rate for all intersections
m = Millions of vehicles entering intersection
k = constant (k=1.282 using 90% confidence level)

Example: The average daily traffic entering an intersection is 21400, 22000, 22300, 22600 and 23060, respectively for years 2003-2007. Find the critical collision rate using 90% confidence level (k = 1.282).

M = (21400 + 22000 + 22300 + 22600 + 23060) x 365.25 = 40.67 million vehicles

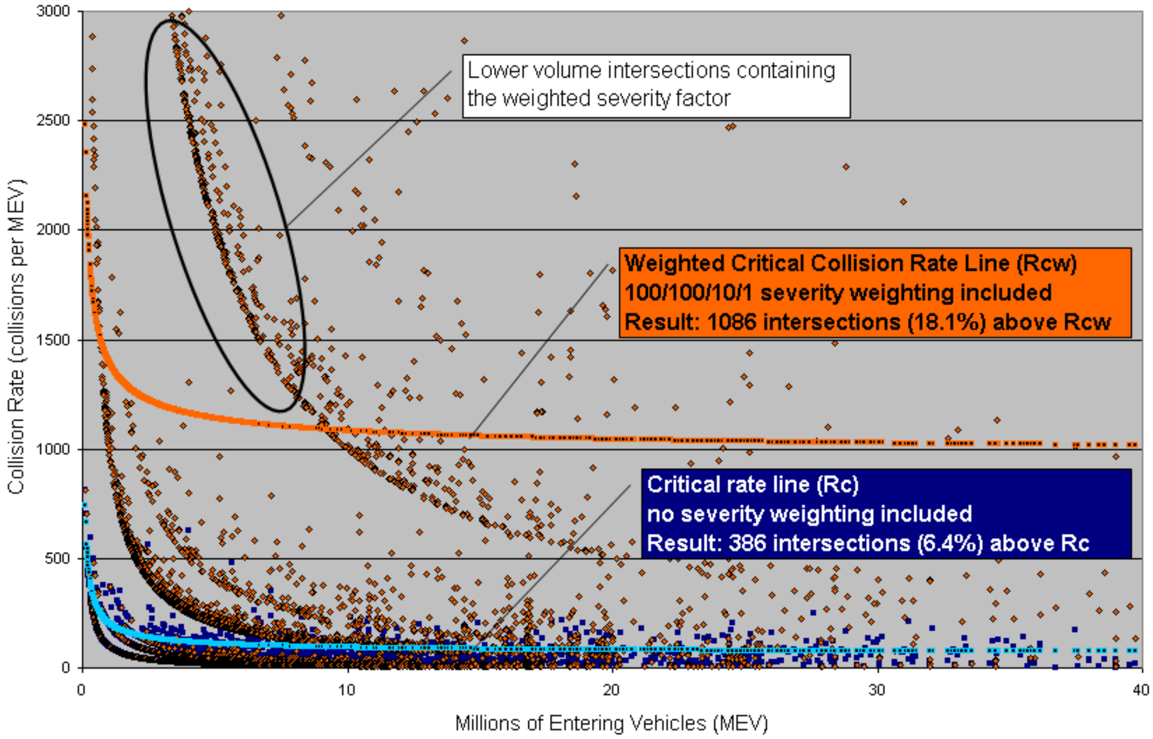
Raw = assume 158 collisions per 100 million entering vehicles (or 1.58 collisions per million entering vehicles)

Rc = 1.58 + (1.282)$(1.58/40.67)^{1/2}$ + 1/(2x40.67)
Rc = 1.58 + 0.252 + 0.012
Rc = 1.84 EPDO collisions per million entering vehicles
or 184 EPDO collisions per 100 million entering vehicles.

The Critical Rate Method suggests the intersection in the example above is more hazardous since the actual collision rate of the intersection exceeds the critical collision rate.

The analysis is repeated for all the intersections in the data set and the resulting graph is shown in Figure 2. The collision rates and critical collision rates calculated with and without the severity weighting are shown in Figure 2 for comparative purposes.

Figure 2: Weighted Critical Collision Rate
100/100/10/1 severity weighting applied



There were 1086 intersections (18.1%) that exceeded the critical rate, when severity weightings were included in the calculation. By adding the 100/100/10/1 severity weighting to the frequency used to compute the rates, it can be seen that the rates are much higher than the rates that exclude severity. Also, the intersections above the critical rate line appear to be concentrated more on the lower volumes intersections on the left side of the graph.

4.2 Weighted Critical Rate (using 40/40/3/1 severity weighting)

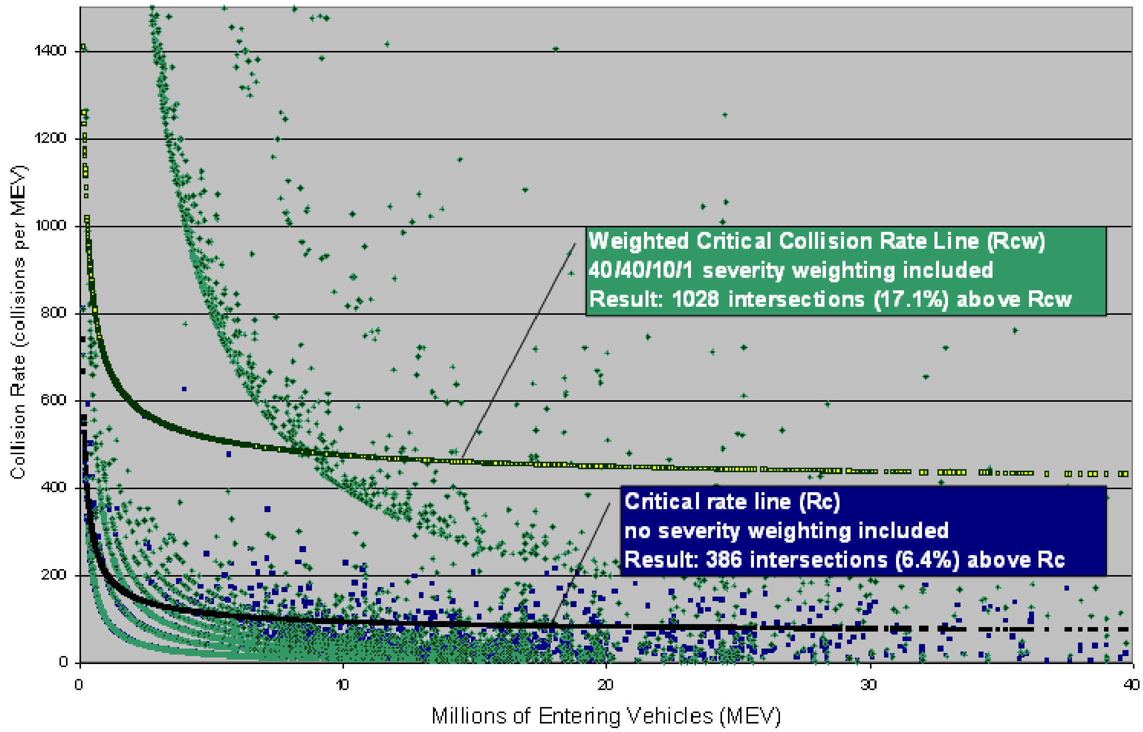
The procedure outlined in section 4.1 is repeated using a different severity rating, as shown in equation 6.

$$EPDO = 40F + 40MAJ + 3MIN + PDO \qquad \text{(Equation 6)}$$

The 40/40/3/1 severity weighting is the proportion of cost breakdown attributed to Fatal / Major Injury / Minor Injury / PDO collisions for the entire intersection data set, according to the procedure outlined by the U.S. Federal Highway Administration (4).

The collision rate and critical collision rate is re-calculated using the 40/40/3/1 weighting (using equations 3 and 4) and the resulting graph is shown in Figure 3.

Figure 3: Weighted Critical Collision Rate
40/40/3/1 severity weighting applied



Although the average rate is lower than that shown for the 100/100/10/1 severity weighting distribution in Figure 2, the pattern in Figure 3 is quite similar where a high concentration of points above the critical rate are representative of low volume intersections. A total of 1028 intersections (17.1%) are found to be above the critical rate line.

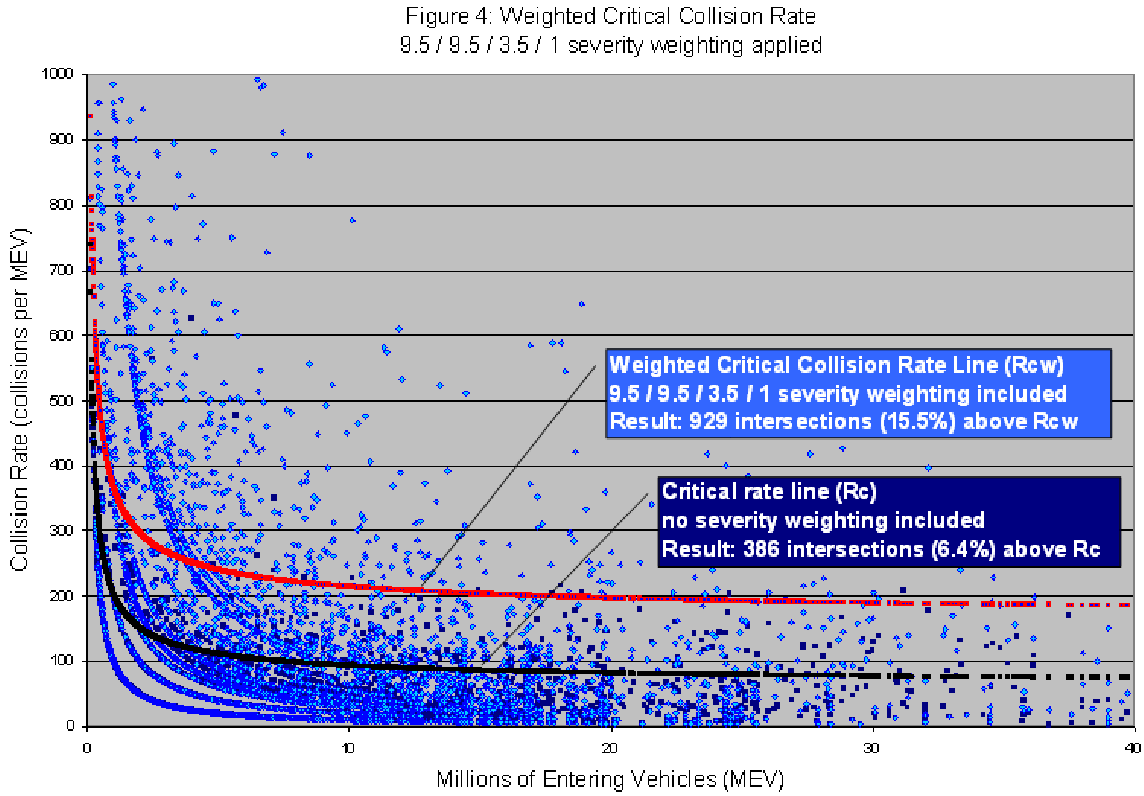
4.3 Weighted Critical Rate (using 9.5/9.5/3.5/1 severity weighting)

The procedure outlined in section 4.1 is again repeated using a different severity rating, as shown in equation 7.

$$EPDO = 9.5F + 9.5MAJ + 3.5MIN + PDO \quad \text{(Equation 7)}$$

The 9.5/9.5/3.5/1 severity weighting used in the above equation is found in several publications, including ITE (3). These weightings place considerably less emphasis on fatal and major injury collisions.

The collision rate and critical collision rate is re-calculated using equations 5 and 6 and the resulting graph is shown in Figure 4.



A total of 929 intersections (15.5%) exceeded the critical rate line in Figure 4.

4.4 Critical Casualty Collision Rate (using casualty collisions only)

The collision rate / critical collision rate calculation was repeated again, but instead of using a weighting factor, only casualty collisions were used in the collision frequency, as outlined in equations 8 and 9.

$$Rf = \frac{Cf \times 10^8}{\sum AADT \times 365.25} \qquad \text{(Equation 8)}$$

Where:
Cf = number of casualty collisions in the five year collision record,
∑AADT = the sum of the average daily traffic entering the intersection for each year over the five years

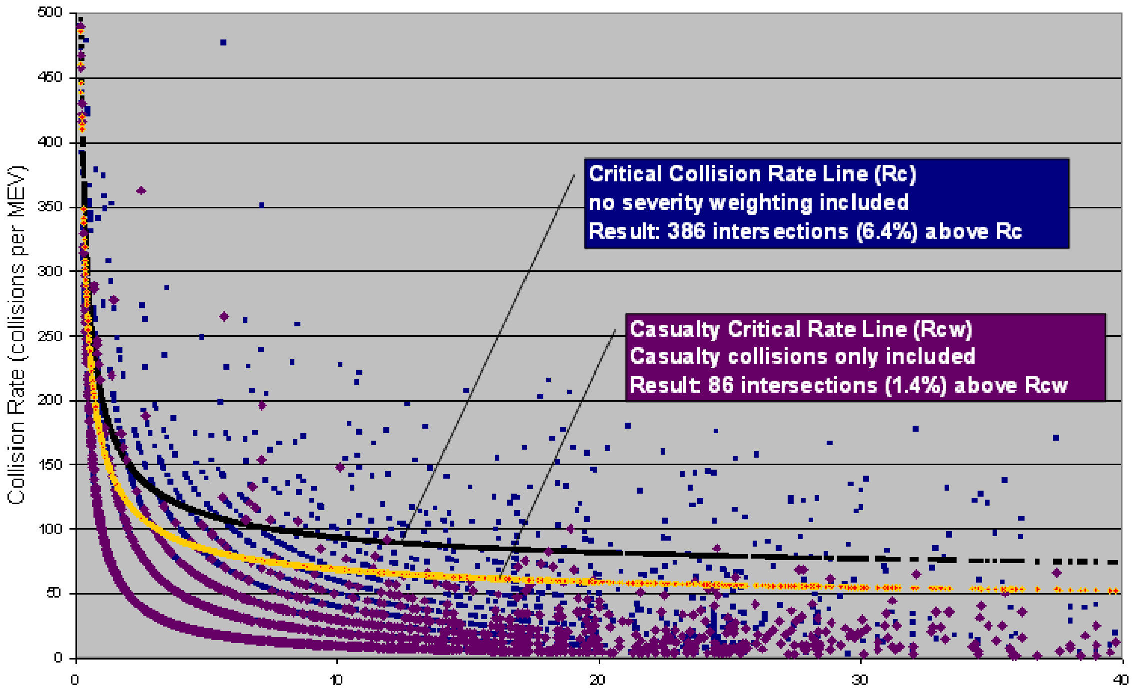
The Critical Casualty Collision Rate is calculated using equation 9.

$$Rcf = Raf + k\sqrt{\frac{Raf}{m}} + \frac{1}{2m} \qquad \text{(Equation 9)}$$

Where:
Rcf = Critical Casualty Collision Rate using casualty collisions only
Raf = Average casualty collision rate for all intersections
m = Millions of vehicles entering intersection
k = constant (k=1.282 using 90% confidence level)

Figure 5 below shows the results of applying the above calculation to the intersection data set containing only casualty collisions.

Figure 5: Critical Casualty Collision Rate
casuallty collisions only applied



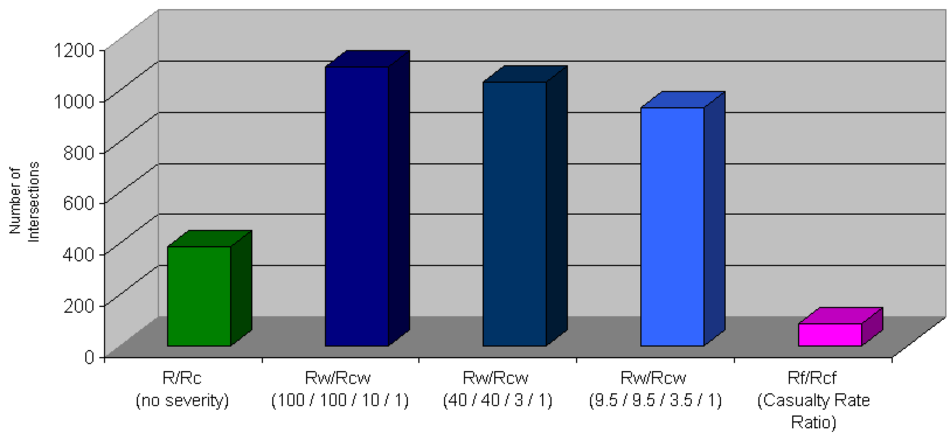
Only 86 intersections out of a possible 3325 intersections (2.3%) having at least one casualty collision are found to exceed the critical rate using this method. This represents 1.4% of the total number of intersections having one or more collisions in a five year period.

4.5 Number of intersections above critical rate

Table 1 below summarizes the different screening methods using severity weightings within the critical rate method, to show a comparison of the total number of intersections that are deemed “unacceptable”. A graph is also shown to aid in the comparisons, with the bars representing the numbered screening methods from left to right.

By comparison, adding a severity weighting to the collision rate and critical collision rate significantly increased the number of intersections that exceeded the critical rate line.

Table 1: Number of Deficient Intersections Identified by Different Screening Methods			
ID#	Screening Method	Number of Intersections	Percentage of Network
1	R/Rc (no severity)	386	6.4%
2	Rw/Rcw (100 / 100 / 10 / 1)	1086	18.1%
3	Rw/Rcw (40 / 40 / 3 / 1)	1028	17.1%
4	Rw/Rcw (9.5 / 9.5 / 3.5 / 1)	929	15.5%
5	Rf/Rcf (Casualty Rate Ratio)	86	1.4%
Total Intersections		5995	



5.0 Combined Ranking Method

The procedure outlined in this section was developed to provide a screening method that includes collision severity as well as exposure. It uses individually ranked lists consisting of the Critical Rate Method and the Weighted Severity Method and combining these two lists into a single ranked list used for safety screening.

For the first step, the critical rate method is used to calculate the Critical Rate Ratio (R/Rc), which is the ratio between the actual collision rate and the critical collision rate found in equations 1 and 2.

$$\text{Critical Rate Ratio} = R / Rc \qquad \text{(Equation 10)}$$

Where:
R = Collision Rate found in equation 1
Rc = Critical Collision Rate found in equation 2

No severity weightings are applied to this ratio. The critical rate ratio is computed using equation 10 and the results are ranked in descending order and indexed, as shown in the example below.

> Example: Assume 5 intersections have a Critical Rate Ratio of
> INT#1 = 0.86,
> INT#2 = 1.32,
> INT#3 = 0.95,
> INT#4 = 1.09,
> INT#5 = 1.18.
>
> The following ranked list in descending order would then be:
> Ranking (R/Rc) = {1.32, 1.18, 1.09, 0.95, 0.86}
> for {INT#2, INT#5, INT#4, INT#3, INT#1}

The indexed ranking is found by dividing each critical rate ratio by the maximum critical rate ratio.

> Example: Using ranked list above, the indexed ranking is:
>
> Indexed Ranking (R/Rc) = {1.32/1.32, 1.18/1.32, 1.09/1.32, 0.95/1.32, 0.86/1.32}
> Indexed Ranking (R/Rc) = {1.0, 0.89, 0.83, 0.72, 0.65}
> for {INT#2, INT#5, INT#4, INT#3, INT#1}

The above calculation is performed for all the intersections in the data set to create an indexed ranking list based on Critical Rate Ratio.

The second step is to create an indexed list for Weighted severity (EPDO). The 9.5/9.5/3.5/1 weightings found in equation 7 were calculated for all the intersections in the data set and ranked in descending order according to their EPDO value. An example is provided below.

> Example:
> Assume 5 intersections have Equivalent Damage Only Collisions calculated as:
> INT#1 = 256,
> INT#2 = 66,
> INT#3 = 26,
> INT#4 = 18,
> INT#5 = 520
>
> The following ranked list in descending order would then be:
>
> Ranked (WF) = {520, 256, 66, 26, 18}
> for {INT#5, INT#1, INT#2, INT#3, INT#4}
>
> The indexed ranking is found by dividing the weighted severity by the highest weighted severity value.
>
> Example: Using ranked list above, the index is:
>
> Indexed (EPDO) = {520/520, 256/520, 66/520, 25/520, 18/520}

Indexed (EPDO) = {1.0, 0.49, 0.13, 0.05, 0.03}
for {INT#5, INT#1, INT#2, INT#3, INT#4}

The third step is to combine the two lists using equation 11:

$$Ranking = k_1 \times indexed(\frac{R}{Rc})_i + k_2 \times indexed(EPDO)_i \quad \text{(Equation 11)}$$

For this evaluation, the critical collision rate and the weighted severity was given equal consideration.

i.e.; $k_1 = k_2 = 0.5$

Example:
Combined Index Ranking for {INT#1, INT#2, INT#3, INT#4, INT#5}
= (0.65 x 0.5) + (0.49 x 0.5),
(1.00 x 0.5) + (0.13 x 0.5),
(0.72 x 0.5) + (0.05 x 0.5),
(0.83 x 0.5) + (0.03 x 0.5),
(0.89 x 0.5) + (1.00 x 0.5)

= {0.57, 0.56, 0.37, 0.43, 0.99}

Resorting order based on combined indexed rankings
= {0.99, 0.57, 0.56, 0.43, 0.37} for {INT#5, INT#1, INT#2, INT#4, INT#3}

Combined ranking order incorporating collision severity and critical collision rate is therefore:
INT#5
INT#1
INT#2
INT#4
INT#3

6.0 Comparison of Screening Methods

The top 500 intersections for each method shown in Sections 4 and 5 are compared and reviewed in more detail.

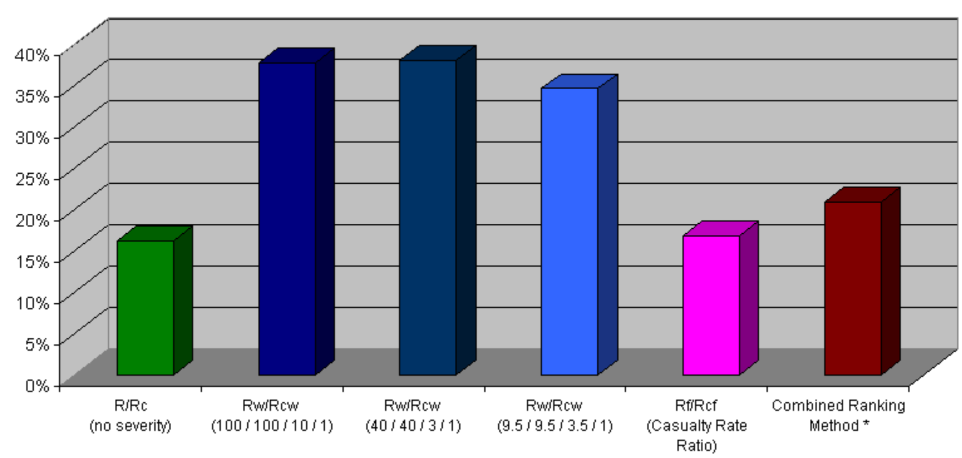
6.1 Proportion of Intersections Having Severe Collision Types

Table 2 shows there were 1317 intersections having at least one fatal or major injury collision in the dataset. Each method is examined to determine the number of intersections that are screened with having at least one fatal or major injury collision. Methods 2, 3 and 4 appear to pick up the highest percentage of intersections with fatal and serious injury, using the weighing factors within the critical rate formula, based on the top 500 ranked intersections for each screening method.

Table 2: Top 500 Ranked Intersections by Screening Method Having One or More Fatal or Major Injury Collisions

ID#	Screening Method	Number of Intersections	Percentage of Total
1	R/Rc (no severity)	213	16.2%
2	Rw/Rcw (100 / 100 / 10 / 1)	497	37.7%
3	Rw/Rcw (40 / 40 / 3 / 1)	501	38.0%
4	Rw/Rcw (9.5 / 9.5 / 3.5 / 1)	456	34.6%
5	Rf/Rcf (Casualty Rate Ratio)	221	16.8%
6	Combined Ranking Method *	276	21.0%
Total Intersections Having One or More Fatal or Major Injury Collisions		1317	

* Combined Ranking Method = (Critical Collision Rate Ratio + Weighted Frequency)



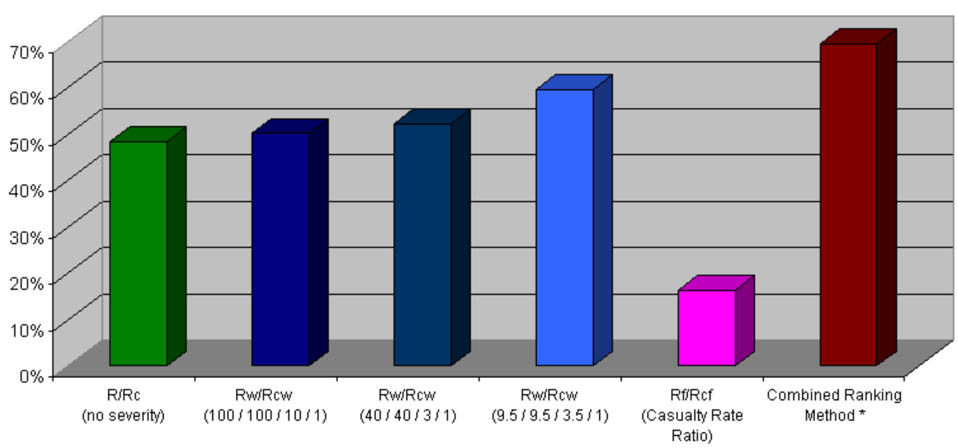
6.2 Proportion of Intersections Having More than One Severe Collision

Table 3 indicates there are 233 intersections that have more than one fatal or major injury collision. Method 6 showing the combined ranking method appears to include more intersections that have multiple fatal and / or major injury type crashes. Method 5 using only injury and fatal collisions for the top 500 intersections provides a low response in screening intersections with more than one severe collision.

Table 3: Top 500 Ranked Intersections by Screening Method Having More than One Fatal or Major Injury Collision

ID#	Screening Method	Number of Intersections	Percentage of Total
1	R/Rc (no severity)	113	48.5%
2	Rw/Rcw (100 / 100 / 10 / 1)	117	50.2%
3	Rw/Rcw (40 / 40 / 3 / 1)	122	52.4%
4	Rw/Rcw (9.5 / 9.5 / 3.5 / 1)	139	59.7%
5	Rf/Rcf (Casualty Rate Ratio)	38	16.3%
6	Combined Ranking Method *	162	69.5%
Total Intersections Having More Than One Fatal or Major Injury Collision		233	

* Combined Ranking Method = (Critical Collision Rate Ratio + Weighted Frequency)



6.3 Proportion of Intersections Considered Collision Monitoring Locations

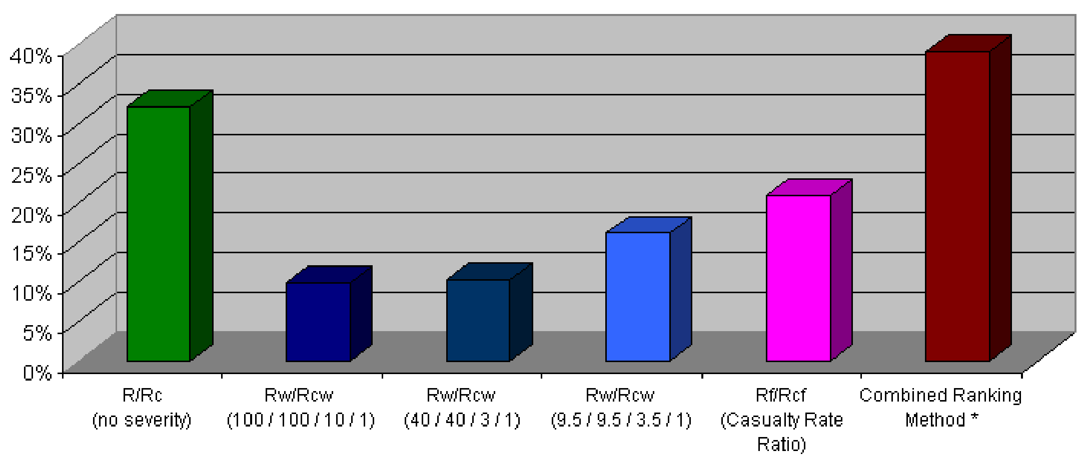
Table 4 shows there are 1053 intersections that were considered special monitoring locations (3 similar type of collisions within the five year collision record). Method 6 using the top 500 intersections included more special monitoring locations within the dataset as compared to the other screening methods outlined in Section 4.

When comparing the top 500 intersections by each method, adding the severity weighting to the critical rate in Section 4 shows a relatively poor occurrence (about 10-15%) of special monitoring locations in the screened intersection list.

Table 4: Top 500 Ranked Intersections by Screening Method
Number of Special Monitoring Locations (SML's)

ID#	Screening Method	Number of Intersections	Percentage of Total
1	R/Rc (no severity)	337	32.0%
2	Rw/Rcw (100 / 100 / 10 / 1)	104	9.9%
3	Rw/Rcw (40 / 40 / 3 / 1)	107	10.2%
4	Rw/Rcw (9.5 / 9.5 / 3.5 / 1)	170	16.1%
5	Rf/Rcf (Casualty Rate Ratio)	220	20.9%
6	Combined Ranking Method *	411	39.0%
Total Intersections Identified as a Special Monitoring Location (SML)		1053	

* Combined Ranking Method = (Critical Collision Rate Ratio + Weighted Frequency)



6.4 Proportion of Intersections Having More than 3 Collisions

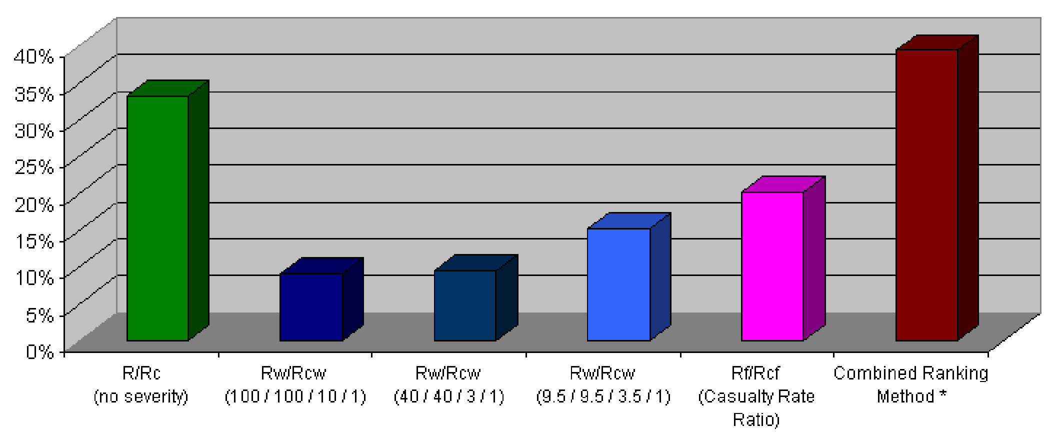
Table 5 shows there were 1159 intersections out of 5995 that had more than 3 collisions in the five year collision record. The combined ranking in Method 6, using the top 500 intersections, includes more intersections with 3 or more collisions than the other screening methods.

This suggests that the critical rate methods outlined in Section 4 includes more intersections with fewer collisions in the safety screening. Screening intersections with relatively few collisions may not be desirable, and Method 6 may be more effective in screening high collision locations.

Table 5: Top 500 Ranked Intersections by Screening Method Having More than Three Collisions

ID#	Screening Method	Number of Intersections	Percentage of Total
1	R/Rc (no severity)	384	33.1%
2	Rw/Rcw (100 / 100 / 10 / 1)	105	9.1%
3	Rw/Rcw (40 / 40 / 3 / 1)	110	9.5%
4	Rw/Rcw (9.5 / 9.5 / 3.5 / 1)	176	15.2%
5	Rf/Rcf (Casualty Rate Ratio)	234	20.2%
6	Combined Ranking Method *	456	39.3%
Total Intersections Having More Than Three Collisions		1159	

* Combined Ranking Method = (Critical Collision Rate Ratio + Weighted Frequency)



6.5 Proportion of Intersections Showing Total Number of Collisions

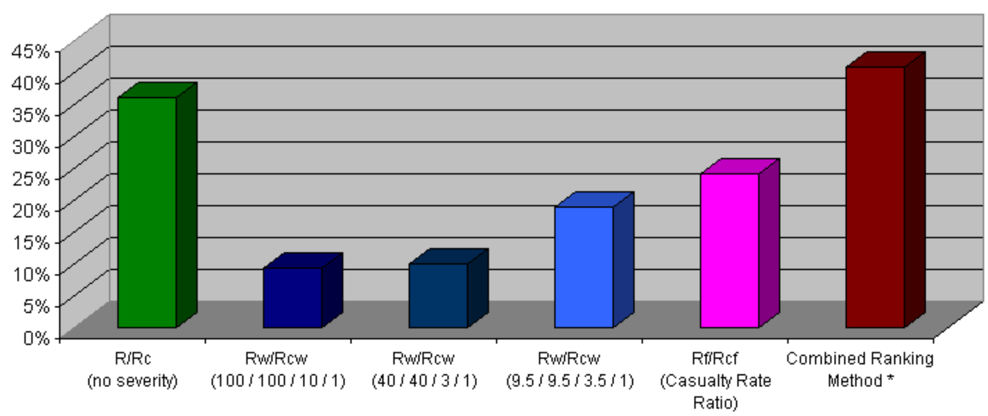
Table 6 shows there were 18,547 collisions total in the data set. The combined ranking method outlined in Method 6 includes more total collisions in the screening than the other methods.

The critical rate methodology outlined in Method 2 (using 100/10/1 weighting), and Method 3 (using 40/40/3/1 weighting) show the lowest proportion of overall collisions in the safety screening. This suggests the weighted critical rate methodology identifies more intersections having fewer collisions in the safety screening.

Table 6: Top 500 Ranked Intersections by Screening Method
Total Number of Collisions (2003-2007)

ID#	Screening Method	Number of Intersections	Percentage of Total
1	R/Rc (no severity)	6700	36.1%
2	Rw/Rcw (100 / 100 / 10 / 1)	1729	9.3%
3	Rw/Rcw (40 / 40 / 3 / 1)	1850	10.0%
4	Rw/Rcw (9.5 / 9.5 / 3.5 / 1)	3509	18.9%
5	Rf/Rcf (Casualty Rate Ratio)	4479	24.1%
6	Combined Ranking Method *	7555	40.7%
Five Year Collision Total (2003-2007)		18547	

* Combined Ranking Method = (Critical Collision Rate Ratio + Weighted Frequency)



6.6 Proportion of Intersections Showing Total Entering Vehicles

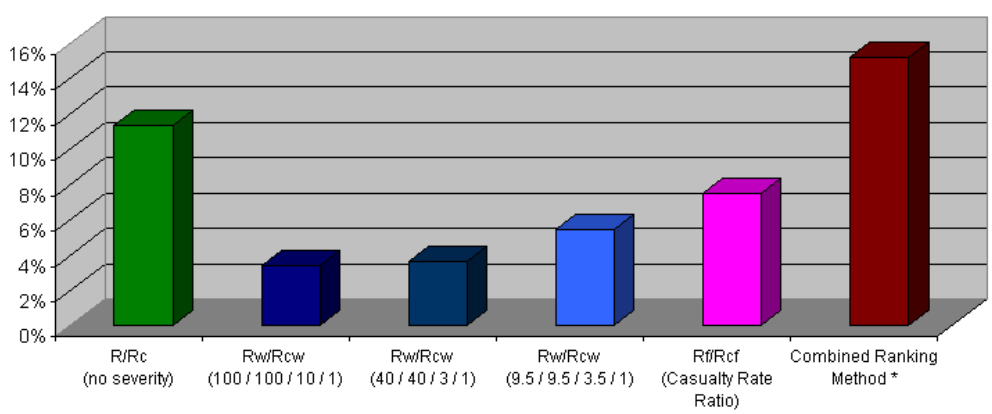
Table 7 shows there were 44.41 billion vehicles entering all the intersections included in the data. The combined ranking used in Method 6 included more vehicles (exposure) in the outcome when compared to the top 500 rankings for the other screening methods.

The critical rate calculation in Method 1 (no severity included) is also effective in identifying intersections with high exposure in the safety screening. Conversely, the weighted critical rate used in Methods 6, 7 and 8 appear to include intersections with lower exposure in the screening.

Table 7: Top 500 Ranked Intersections by Screening Method
2003-2007 Total Traffic Entering Intersections (in billions)

ID#	Screening Method	Number of Intersections	Percentage of Total
1	R/Rc (no severity)	5.0	11.4%
2	Rw/Rcw (100 / 100 / 10 / 1)	1.5	3.4%
3	Rw/Rcw (40 / 40 / 3 / 1)	1.6	3.6%
4	Rw/Rcw (9.5 / 9.5 / 3.5 / 1)	2.4	5.5%
5	Rf/Rcf (Casualty Rate Ratio)	3.3	7.5%
6	Combined Ranking Method *	6.8	15.2%
Total Traffic Entering Intersections (in billions)		44.4	

* Combined Ranking Method = (Critical Collision Rate Ratio + Weighted Frequency)



7.0 CONCLUSION

Including the weighted severity values within the critical rate formula, as outlined in Section 4, screens a relatively large number of intersections which may be considered excessive in terms of managing safety reviews and intersection improvement needs on the provincial highway network. The majority of these sites appear to be low volume intersections.

The second and third terms of critical rate formula found in equation 2 do not appear to adjust when the weighting values for severity are applied to the rate calculation. The result is a critical rate which is close to the average value, and then increases sharply near the origin. The critical rate method using weighted severity appears to miss many intersections that are special monitoring locations, has the lowest total number of collisions, and does not include a high percentage of traffic entering the intersections (exposure), as compared to using critical collision rate alone.

Although many publications exist on safety screening methods, literature on using weighting values within the critical rate formula is scarce, and observation show the critical rate line does not fit well with values other than “typical” collision rates.

Use of the Critical Collision Rate without the severity weightings appears to capture an acceptable number of intersections having Fatal and Major Injury type collisions. However, by ranking and combining the collision rate ratio and the weighted severity lists, combined method accounts for greatest number of special monitoring locations, most multiple severe collision types, highest total traffic entering and includes the most number of collisions when compared to the other screening methods.

8.0 FURTHER STUDY

Continued work is on-going for the Combined Ranking Method being used by Alberta Transportation. This safety screening calculation appears to be a better method for including both severity and rate in the screening process.

Some further work is required on how this screening method affects other road elements such as road segments, curves, bridges, railway crossings, etc., and whether the same methodology applies.

The combined ranking method used the 9.5 / 9.5 / 3.5 / 1 severity weighting for Fatal / Major Injury / Minor Injury / PDO collision types. The severity weighting used to calculate Equivalent Property Damage Only collisions varies significantly between publications, and further research is needed on how different severity weightings will impact the combined ranking method.

Changing the k1 and k2 values in the combined ranking method outlined in equation 12 could allow more emphasis on either collision rate (exposure) or severity. These results could be further examined to see how these changes affect the overall screening effect.

Additional research could consider whether incorporating severity into the Rate Quality Method yields a benefit when implementing mitigation measures vs. the more standard approaches.

9.0 REFERENCES

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